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TITLE: System for monitoring the movements of one or more point sources of luminous radiation

Abstract Text (1):

Several virtually punctiform, sequentially excited sources of luminous radiation on a pilot's helmet facilitate continuous determination of the pilot's line of sight with the aid of a linear array of photoelectric cells illuminated via a pair of mutually parallel cylindrical lenses perpendicular to the array. The light path through one of these lenses includes a beam rotator in the form of two juxtaposed prisms which turns one of two sheets of light rays from an excited source, lying originally in two mutually orthogonal planes, through 90.degree. into a plane including the axis of one of the lenses so as to intersect the array in one point while the other sheet of light rays retains its orientation in passing through the axis of the other lens to intersect the array in another point. The locations of the two points of intersection, periodically detected by a charge-coupled scanner, indicate the momentary direction of the active source whose exact position can thus be established with the aid of two radiation sensors of the type described. Alternatively, with three point sources whose mutual distances are known, the positions of these sources can be derived from their respective directions as determined by one such sensor. The nonrotated sheet of rays may pass through a simple prism serving to compensate for the difference in the path lengths of the two sheets. Two pulse counters normally synchronized with the scanner are stepped at half their normal rate in the presence of an output signal from the scanner indicative of incident radiation, thereby determining the position of a cell at or near the middle of a series of neighboring cells illuminated by such radiation.

Brief Summary Text (7):

The principal object of our present invention is to provide an improved radiation-monitoring system of the general type described, utilizing only one elongate radiation detector for direction determination while avoiding the use of slitted masks so as to make available a broad field of radiant energy for the localized illumination of that detector.

Brief Summary Text (10):

In accordance with our present invention, a radiation sensor coacting with one or more virtual point sources comprises a first and a second cylindrical lens member extending parallel to each other across an elongate radiation detector to focus incident rays from such a source onto certain portions of the detector, e.g. one or more photocells closely juxtaposed in a linear array. The path of radiation incident on the first lens member includes beam-rotating means for turning a first sheet of rays, lying in one of two mutually orthogonal planes, through 90.degree. into a third plane which includes the axis of the first lens member. A second sheet of rays transverse to the first sheet passes through the axis of the second lens member whereby the two sheets of rays intersect the radiation detector at respective points defining with the lens axes the positions of the two mutually orthogonal planes. The locations of these points of intersection are ascertained by output circuitry coupled to the radiation detector and connected to a processor

which determines from these locations the direction of the source with respect to the radiation detector.

Brief Summary Text (15):
Even with a pair of carefully designed cylindrical lenses, the beams respectively focused by them upon the radiation detector will generally illuminate several adjoining cells simultaneously since, with the sources located at finite and variable distances from the sensor, their linear images will not precisely coincide with the focal planes of the lenses. According to an advantageous further feature of our invention, therefore, we control the stepping of the counter or counters by the timer in such a way that the counting rate is halved in response to an output signal from the threshold circuit indicative of detected radiation whereby the rank indicated by the count refers to a cell at or near the middle of a series of simultaneously illuminated cells.

Drawing Description Text (3):
FIG. 1 is an isometric view of a radiation sensor embodying our invention;

Drawing Description Text (4):
FIGS. 2A, 2B and 2C are, respectively, a top view and two side views of a beam rotator included in the sensor of FIG. 1;

Drawing Description Text (5):
FIG. 3 schematically illustrates the overall monitoring system according to our invention, with the beam rotor omitted for the sake of simplicity;

Drawing Description Text (6):
FIG. 4 shows part of the sensor of FIG. 1 modified by the addition of a path-length compensator;

Drawing Description Text (8):
FIG. 6 is a circuit diagram of the electrical components of our monitoring system; and

Detailed Description Text (3):
Sources S.sub.A, S.sub.B and S.sub.C are sequentially energized, as more fully described hereinafter, to facilitate their tracking by a radiation sensor RS including the detector 1, centered on an axis x.sub.1, and a pair of planoconvex cylindrical lenses 2, 3 with mutually parallel axes y.sub.2, y.sub.3 and focal lines F.sub.2, F.sub.3 lying in planes of symmetry perpendicular to axis x.sub.1. The flat lower faces of lenses 2 and 3 are coplanar and are separated from a confronting upper face of detector 1 substantially by their focal length f as indicated in FIG. 1, focal lines F.sub.2 and F.sub.3 thus lying close to the level of that face.

Detailed Description Text (10):
With the use of a single sensor and three sources S.sub.A, S.sub.B, S.sub.C (FIG. 3) excited at different times but in close succession, the establishment of their respective directions of incidence D.sub.A, D.sub.B, D.sub.C also enables the location of each source to be determined inasmuch as the distance between any two sources is invariable and known. The combined use of three or more sources and at least two sensors on each side of helmet 9 provides immediate verification of the obtained readings with the aid of the two procedures described; moreover, with the sources necessarily close to one another, a triangulation with the aid of two relatively widely separated sensors is more exact than a calculation of distance based upon the directions of incidence D.sub.A, D.sub.B, D.sub.C.

Detailed Description Text (14):
Reference will now be made to FIG. 6 for a description of an electrical circuit arrangement designed to evaluate the information available from a given radiation

sensor RS. A rectangle 9, symbolizing the pilot's helmet of FIG. 3, carries a power supply 50 adapted to feed the several sources S.sub.A, S.sub.B, S.sub.C through a switching circuit 51 under the control of a switchover signal S.sub.15 periodically emitted by a processor 40; the excitation of any source is reported back to the processor via a respective line 52A, 52B, 52C. Radiation detector 1 is here shown to be illuminated from block 6 and lens 2 via a slit diaphragm 81 and a filter 71; a similar slit diaphragm 82 and filter 72 are interposed between the detector and lens 3. The two slit diaphragms 81, 82, provided for sharper focusing, should of course give passage to rays from any source position within the range to be monitored. Filters 71 and 72 serve to exclude ambient illumination by passing only the spectral band (preferably infrared light) emitted by any sources S.sub.A - S.sub.C.

Detailed Description Text (15):
A scanner 21, advantageously an integrated shift-register circuit of the CCD type discussed above, has a multiplicity of stages respectively connected to the several photocells of detector 1 and is steppable by clock pulses H from a timer 20 to transfer the charges received from the detector through an amplifier 22 to one input of a comparator 23 whose other input receives a threshold voltage from an adjustable supply 53. The output signal SV of scanner 21, after amplification in component 22, gives rise to a signal S.sub.10 including a pair of flat-topped peaks SV.sub.j, SV.sub.k in the output of threshold comparator 23. These peaks are differentiated in an R/C network 54, 55 feeding a pair of antiparallel diodes 26, 27; diode 26 passes only their rising flanks S.sub.11, S.sub.16 (FIG. 7) whereas diode 27 passes only their falling flanks S.sub.12, S.sub.17. The positive spikes from diode 26, corresponding to flanks S.sub.11 and S.sub.16, are respectively directed by a switching circuit 29 to control inputs of two second-state switching circuits 24, 31 also having other control inputs connected to receive the negative spikes from diode 27, corresponding to flanks S.sub.12 and S.sub.17, which are respectively directed thereto by the first-stage switching circuit 29.

CLAIMS:

1. In a system for monitoring the movement of a virtual point source of luminous radiation relative to a detection site,

the combination with said source of a radiation sensor at said detection site comprising:

an elongate radiation detector;

a first and a second cylindrical lens member disposed parallel to each other across said detector and focused upon the latter to direct incident radiation from said source onto limited portions thereof;

beam-rotating means in the path of radiation incident on said first lens member for turning a first sheet of rays incident in a first plane, orthogonal to a second plane containing a second sheet of incident rays, through 90.degree. into a third plane including the axis of said first lens member, said second sheet of rays passing through the axis of said second lens member whereby said sheets of rays intersect said detector at respective points defining with said axes the positions of said first and second planes;

output circuitry coupled to said detector for ascertaining its points of intersection with said sheets of rays; and

processing means connected to said output circuitry for determining from the locations of said points of intersection the direction of said source with respect to said detector.

7. The combination defined in claim 6, further comprising switching means controlled by said threshold means for changing the stepping of said pulse-counting means by said timing means from a normal rate synchronized with the advance of said scanning means to a reduced rate equal to half said normal rate in the presence of an output signal indicative of intense illumination.

8. The combination defined in claim 1 or 2 wherein said sensor is duplicated in different areas of said detection site for intercepting radiation from two different directions converging at said source.

9. The combination defined in claim 1 or 2 wherein said source is part of a group of three virtual point sources of predetermined and invariable relative positions jointly movable with reference to said sensor, said processing means being provided with switching circuitry for individually exciting said sources in cyclic succession.

10. The combination defined in claim 9 wherein said sensor is disposed in a cockpit of an aircraft and said group of sources is mounted on a helmet of a pilot occupying said cockpit.

11. The combination defined in claim 10 wherein said group of sources is duplicated on opposite sides of said helmet, said sensor being duplicated on opposite sides of said cockpit.

12. In a system for monitoring the movement of a virtual point source of luminous radiation relative to a detection site,

the combination with said source of a radiation sensor at said detection site comprising:

elongate radiation-detecting means forming at least one linear array of closely adjoining cells positioned for irradiation by two narrow beams of incident radiation lying in mutually orthogonal planes;

scanning means for sequentially sampling said cells in a succession of sweep cycles;

threshold means connected to said scanning means for receiving therefrom an output signal varying with the degree of illumination of the sampled cells;

timing means responsive to said threshold means for advancing said scanning means at a predetermined speed;

pulse-counting means stepped by said timing means under the control of said threshold means at a normal rate synchronized with said scanning means in the presence of low illumination and at half said normal rate in the presence of high illumination;

storage means controlled by said threshold means to register the count of said pulse-counting means at the end of a period of high illumination to identify the rank of a cell substantially midway in a series of adjoining cells simultaneously illuminated by either of said beams; and

processing means connected to said storage means for determining from said count the direction of incidence of each of said beams.